MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

DCE5038 – ELECTRICAL MEASUREMENT AND INSTRUMENTATION TECHNIQUES

(Diploma in Electronic Engineering)

9 MARCH 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages excluding the cover page and appendix.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Name two elements in measurement systems that can be fitted in box number iii) and then explain those elements.

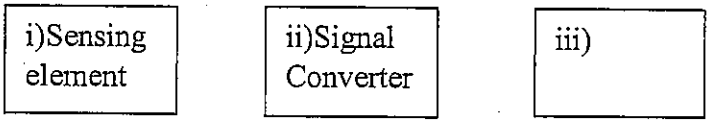

Figure 1

[6 marks]

b) Explain the differences between resolution and sensitivity.

[4 marks]

c) In RC circuit, time constant, τ is measured in seconds. The formula is given as $\tau = RC$. If given $R = 7k \pm 300\Omega$ and $C = 1 \pm 3$ F.

i) Calculate τ.

[8 marks]

ii) If one more resistance, $R_1 = 1k \pm 2\%\Omega$ is connected in series with the existing R in the circuit. Calculate R_{eq}.

[5 marks]

d) Interpret the loading effect in measurement.

[2 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Why is it important to have deflecting force in indicating instrument? Present three example of effect that can produce deflecting forces.

[5 marks]

b) Draw a labelled diagram that can explain how the moving coil pivot when current is flowing inside the coil in a permanent magnet moving coil instrument (PMMC).

[3 marks]

c) Show how spring and eddy current are used as the controlling and damping forces in a PMMC instrument.

[4 marks]

d) Explain the operation of a dynamometer indicating instrument.

[8 marks]

e) For a wattmeter connection stated in Figure 2, calculate power indicated by the wattmeter for the following parameter:

Voltage across load	250 V
Current across load	10 A
Current coil resistance	0.2 Ω
Pressure coil resistance	5.6 kΩ

Table 1

[5 marks]

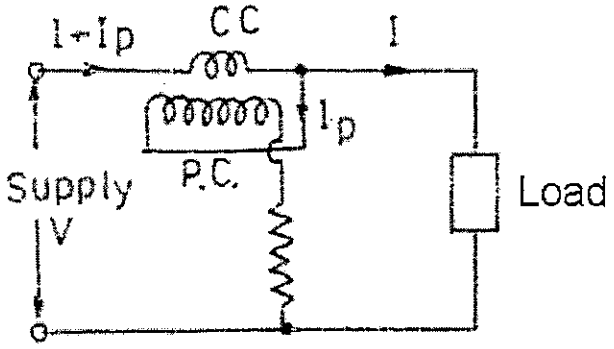

Figure 2

Continued...

QUESTION 3 [25 MARKS]

a) Figure 3 shows a Wheatstone bridge circuit with $R_1 = 1\text{k}\Omega$, $R_2 = 4\,\text{k}\Omega$, $R_3 = 8\,\text{k}\Omega$ and $R_4 = 20\,\text{k}\Omega$. Given that the internal resistance of the galvanometer is 300 Ω.

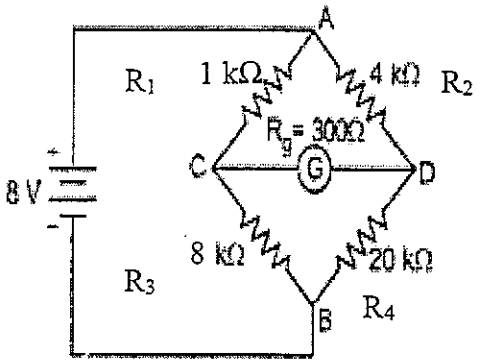

Figure 3

i) Is the circuit balanced? Prove.

[2 marks]

ii) Calculate the current through the galvanometer as shown above.

[9 marks]

b) A Maxwell bridge with a 20 kHz supply frequency has a 0.45 μF standard capacitor and a 100 Ω standard resistor for R_1. Resistors R_3 and R_4 can each be adjusted from 100 Ω to 2 kΩ. Based on the bridge shown in Figure 4, show that:

i) Span of the inductance = 0.855 H.

[7 marks]

ii) If the supply frequency is halved, calculate the span of the Q factor.

[7 marks]

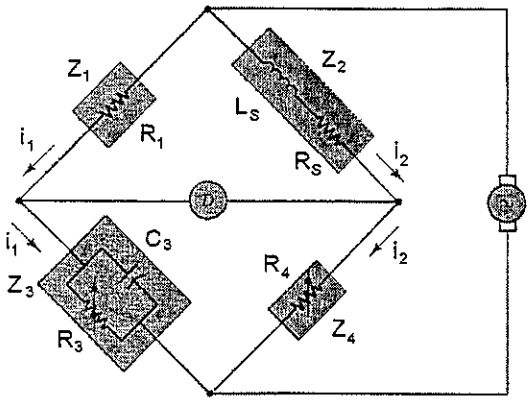

Figure 4

Continued...

QUESTION 4 [25 MARKS]

a) Figure 5 shows the method of reversals to determine the *B-H* curve of a ring specimens.

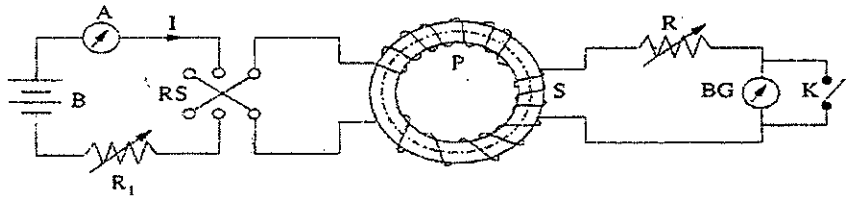

Figure 5

i) How is the value of magnetizing force *H* determined?

[2 marks]

ii) How is the value of magnetizing force *H* changed?

[2 marks]

iii) Why is it necessary to reverse the direction of the current flowing through the primary coil?

[2 marks]

iv) How does the apparatus set up ensure that all the magnetic flux lines, generated by the corresponding magnetizing force, pass through the search coil?

[2 marks]

b) Briefly explain LVDT and how it operates.

[8 marks]

c) Given an LVDT with a sensitivity of 15.22 mV/mm. Calculate the output voltage if the displacement of an object attached is 0.05 m.

[2 marks]

d) A transducer uses two quartz diaphragms of area 650 mm^2 separated by a distance of 3.55 mm. If the permittivity of quartz is 40.6×10^{-12} F/m,

i) Find the capacitance.

[4 marks]

ii) State all principles that might cause a change in capacitance.

[3 marks]

End of Page.

Appendix

$$X = AB$$

$$\frac{\partial X}{\partial A} = B, \frac{\partial X}{\partial B} = A$$

$$E_L = \frac{Z_L}{Z_L + Z_0} E_0$$

$$I_0 = \frac{E_0}{Z_O}$$

$$I_L = \frac{E_0}{Z_L + Z_0}$$

$$T_D = B\ell IND$$

$$Power\ loss\ in\ current\ coil = I^2 R_c$$

$$Power\ loss\ in\ pressure\ coil = \frac{V^2}{R_P}$$

$$QR = PS$$

$$V_{TH} = E\left[\frac{R_3}{R_1 + R_3} - \frac{R_4}{R_2 + R_4}\right]$$

$$R_{TH} = \left[\frac{R_1 R_3}{R_1 + R_3} + \frac{R_2 R_4}{R_2 + R_4}\right]$$

$$I_G = \frac{V_{TH}}{R_{TH} + R_G}$$

$$\frac{P}{Q} = \frac{R + \ell_1 R}{S + (L - \ell_1)R}$$

$$Q = 2\pi f C_3 R_3$$

$$Q = \frac{1}{2\pi f C_3 R_3}$$

$$R_S = \frac{R_1 R4}{R_3}$$

$$L_S = C_3 R_1 R_4$$

$$R_P = \frac{R_1 R4}{R_3}$$

$$L_P = C_3 R_1 R_4$$

$$C_1 = C_2 \frac{R_4}{R_3}$$

$$R_1 = \frac{R_3 C_4}{C_2}$$

$$H = \frac{N_P \ell}{\ell}$$

$$B = \frac{K\theta R_S}{2N_S A}$$

$$e_0 = \frac{X_i}{X_t} e_i$$

$$\nu = -\frac{\partial D / D}{\partial L / L}$$

$$G_f = \frac{\Delta R / R}{\Delta L / L} = 1 + 2\nu + \frac{\Delta\rho / \rho}{\varepsilon}$$

$$\varepsilon = \frac{\Delta L}{L}$$

$$G_f = 1 + 2\nu$$

$$Q = d \times F$$

$$E = \frac{Q}{C}$$

$$E = \left(\frac{d}{\varepsilon}\right) St = gSt$$

$$g = \frac{d}{\varepsilon}$$

$$C = \frac{\varepsilon A}{d}$$

$$R = R_0\left[1 + \alpha_0(\theta - \theta_0)\right]$$

$$R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

$$V_0 = C_1(T_1 - T_2) + C_2\left(T_1^2 - T_2^2\right)$$